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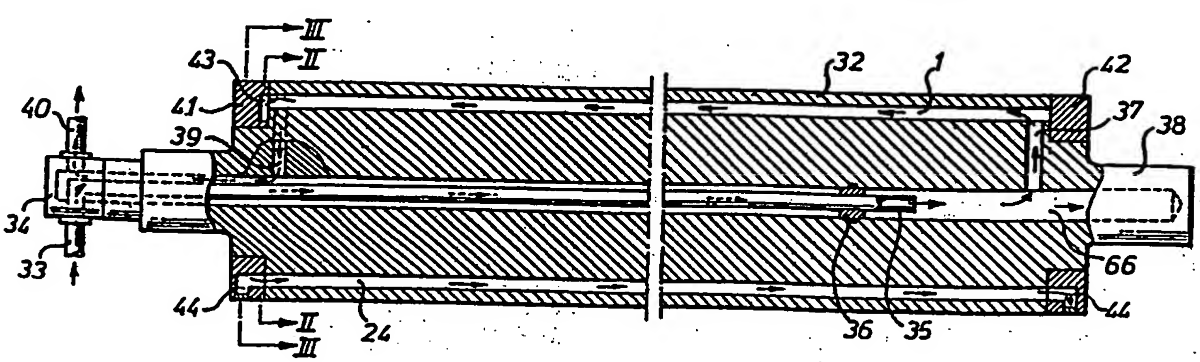

(57) Abstract

A cooled supporting roller intended particularly for use in the continuous casting of steel shapes includes a plurality of axially extending coolant channels (1, 24) which are divided uniformly around the periphery of the roller. All channels are connected in series between a coolant inlet (33) and a coolant outlet (40). The channels are connected in series such that during its passage through the channels between the inlet and the outlet, the coolant will pass at least twice around the periphery of the support roller (32). This results in uniform heating of the roller and also in uniform cooling of the steel shape.

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A Cooled Support Roller

The present invention relates to a cooled support roller and particularly to a support rollerfor use in the continuous casting of steel shapes, said support roller including a number of axially extending coolant channels which are spaced uniformly around the roller periphery and connected in series between a coolant inlet and a coolant outlet.

In the continuous casting of steel plate shapes, the molten steel is tapped from the furnace into a casting box, which functions as a buffer, and from there into a continuous casting mould, which normally has the form of a water-cooled copper mould. The continuous steel casting, or string, which is still fluid in its centre region, is withdrawn from the mould and cooled as it passes through a battery of support rollers which define a smooth and regular curve which gradually passes into a fully horizontal plane.

High demands are placed on the cooling rollers used in such processes. For instance, the cooling rolls shall not become distorted during the cooling process and shall be capable of cooling the continuous casting uniformly.

The use of rollers which include an axially and centrally extending coolant channel has been proposed. The channel lies at some considerable distance from the outer cylindrical surface, or mantle surface, of the roller and the roller is cooled to only a very small extent. Cooling of the roller bearings is the prime achievement. So-called shell rollers have also been used, these rollers consisting of an outer, relatively thick mantle of homogenous steel material and a circum-

ferentially extending coolant pocket formed within the mantle. This roller construction provides a relatively large flow area, and consequently the rate of coolant flow is low and the cooling effect therewith poor. The outer shell, or mantle, must be made thick for reasons of mechanical strength, which also limits the cooling effect.

The so-called revolver roller is a variant of the shell roller and includes a plurality of parallel-connected coolant channels disposed uniformly around the periphery of the roller. Because these channels are connected in parallel, the roller has a large flow area and consequently a low flow rate and therewith a low cooling effect.

The use of a cooling roller having a helical coolant channel located adjacent the roller surface has also been proposed. This channel is produced by milling a helical groove in the outer surface of the roller and then sealing the groove with an outer layer of material, so as to form a closed channel. This results in the formation of sharp, circumferentially extending weakenings which are liable to crack due to fatigue, therewith creating serious problems. Furthermore, it is extremely difficult to open such a channel should the channel become blocked, among other things.

Those demands that should be placed on a cooling roller which is intended for the aforesaid use is that the roller is cooled effectively and uniformly around the whole of its mantle surface, since uneven cooling of the roller can result in deformation of the roller by the thermal stresses induced. A uniformly cooled roller is also a necessity in order for the steel shape to be cooled uniformly irrespective of which part of the

roller mantle coacts with the cast shape. In order to achieve an optimum cooling effect, it is necessary for the coolant to flow at the highest possible speed, which requires a small flow area. Further, it is necessary to be able to detect when a flow channel becomes blocked, since a blocked channel can jeopardize uniform cooling of the roller.

The main object of the present invention is to provide a cooled support roller which will provide the aforesaid advantages while eliminating the drawbacks of known rollers at the same time.

According to the present invention, a cooled, or chilled, support roller of the kind defined in the first paragraph of this document is mainly characterized in that the coolant channels are connected in series such that during its passage between the coolant inlet and the coolant outlet, the coolant will pass through two turns around the periphery of the support, and in that the coolant will pass through each alternate channel during said first turn and through intermediate channels during said second turn.

The use of series-connected channels between the coolant inlet and coolant outlet greatly restricts the coolant flow area, therewith resulting in a high rate of flow and a high cooling effect. This arrangement also provides the advantage that in the event of a channel becoming blocked, the blockage will immediately affect the flow of coolant and can therewith be readily detected, for instance with the aid of a flowmeter. By passing the coolant in two turns, i.e. twice, around the roller periphery, the roller will be cooled much more uniformly than when the coolant is only passed through one turn, as will be explained herebelow.

In a first embodiment of the invention, as defined in Claim 2, the coolant is passed in two turns around the roller periphery in one and the same direction. In another embodiment, as defined in Claim 4, the coolant is first passed through one turn around the periphery in one direction and is then caused to pass around the periphery in another direction in said second turn, which provides a more uniform cooling effect than the first embodiment.

When transferring coolant from one channel to the next nearest channel and from this latter channel to the next nearest channel, a connecting ring can be employed at the two end surfaces of the support roller concerned, as defined in greater detail in Claim 5. A roller provided with such coolant channels can be reconditioned relatively easily in the event of a channel blockage.

Claim 7 defines an alternative method of connecting pairs of coolant channels on each side of an intermediate channel with the aid of bores drilled obliquely from the outer surface of the support roller.

Other features of the inventive support roller are defined in the remaining Claims.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings.

Figure 1 is a longitudinal section view of a first embodiment of an inventive cooled support roller.

Figure 2 is a cross-sectional view taken on the line II-II in Figure 1.

Figure 3 is a cross-sectional view taken on the line III-III in Figure 1.

Figure 4 is a spread sheet illustrating the course followed by the coolant channels in the roller illustrated in Figure 1.

Figure 5 is a longitudinal sectional view of a second embodiment of an inventive cooled support roller.

Figure 6 is a view taken on the line VI-VI in Figure 5.

Figure 7 is a view taken on the line VII-VII in Figure 5.

Figure 8 is a spreadsheet which illustrates schematically the course followed by the coolant channels in the roller shown in Figure 5.

Figure 1 illustrates a cooled, or chilled, support roller 32 which is provided with thirty-one (31) axially extending coolant channels 1-31, see also Figures 2 and 3, which are disposed uniformly around the roller periphery and located close to the surface thereof. The channels are connected in series and conduct a coolant, normally water, in a given channel order, said coolant being delivered through an inlet conduit 33 to a swivel device 34 of known construction. The water is delivered via the swivel 34 to a tube 35 arranged in a central, axially extending channel 66, wherein a ring seal 36 is fitted between the outer cylindrical surface of the tube 35 and the inner surface of the channel 66. The water flows through the tube 35 and out into the channel 66 beyond the seal 36, wherewith the water flows through a radial connecting channel 37 into the first coolant channel 1 of the coolant channels 1-31. Option-

ally, the tube 35 may first discharge into the roller bearings, or trunnions 38, so as to effectively cool the trunnions.

The water delivered to the central channel 66 will circulate through the thirty-one channels, as described in more detail below, and is delivered finally from the channel 31 to the annular space between the inner wall of the channel 66 and the tube 35 through a radial connecting channel 39, and is discharged through an outlet pipe 40 connected to the swivel 34.

Accordingly, all thirty-one coolant channels are connected in series between the swivel inlet pipe 33 and the swivel outlet pipe 40, in a manner such that the cooling water will pass through two turns around the roller periphery during its passage between the inlet and outlet. This series-connection of the channels will now be described in more detail.

For the purpose of mutually connecting the channels, a channel connecting ring 41 and 42 respectively are placed in sealing abutment with an outer part of the two end surfaces of the roller 32. As shown in Figure 3, each alternate coolant channel extends slightly into a respective connecting ring 41 and 42, whereas the channels lying therebetween terminate in the boundary surface between a respective ring and its associated end surface of the roller. The ring surface that lies proximal to the roller has formed therein U-shaped grooves 43, see Figure 2, which connect in pairs those channels which terminate in said boundary surface. Those channels which extend into respective connecting rings 41 and 42 are connected in pairs in said rings with the aid of apertures 44 milled in the cylindrical surface of the rings, see Figure 3. Thus, each alter-

nate coolant channel extends into the connecting ring, whereas intermediate coolant channels terminate in the boundary surface between the connecting ring and the end surface of the roller.

The sectional view presented in Figure 1 shows the U-shaped groove 43 in the ring 41 that connects the coolant channel 1 with the coolant channel 2, and the milled aperture 44 in the ring 41 that connects the coolant channel 23 with the coolant channel 24. The Figure also shows the aperture 44 in the ring 42 that connects the coolant channel 24 with the coolant channel 25 at the right end of the roller.

The coolant water delivered to the coolant channel 1 of the Figure 1 illustration at the right end of said channel is thus connected to the coolant channel 2 at the left end through the U-shaped groove 43 in the inner surface of the ring 41 (see Figure 2), and is then connected to the coolant channel 3 at the other end surface of the roller, through a corresponding U-shaped groove in the connecting ring 42. When the water returns, the water is delivered to the coolant channel 4, and so on, wherein after passing through about one revolution, the water returns in the coolant channel 17, which extends into the connecting ring 41, and is connected in said ring 41 with the coolant channel 18, through an aperture 44, see Figure 3. Correspondingly, the channel 18 at the other end of the roller extends into the connecting ring 42 where it connects with the coolant channel 19 through a similar aperture, this latter channel 19 being connected in the ring 41 with the coolant channel 20, and so on. Finally, subsequent to having passed through almost two turns or revolutions around the roller periphery, the water returns in the coolant channel 31, from which the water is deli-

vered to the centre channel 66 and the swivel outlet pipe 40, through the radial channel 39.

By using a plurality of coolant channels connected in series in this way, there is afforded, among other things, the advantage that the flow rate in the channel will be high and a good cooling effect achieved. Furthermore, blockage of a channel will be detected immediately, through a corresponding reduction in the flow rate. Furthermore, the use of many narrow channels enables the channels to be placed very close together and at a small depth beneath the outer surface of the roller, therewith greatly improving the cooling effect. Another advantage is that coolant channels which tend to become blocked, can be drilled open when renovating the cooling roller, which can be effected subsequent to separating the connecting rings 41 and 42. The channels are then accessible for reconditioning. As will be understood, the U-shaped grooves 43 can be formed in the corresponding end surface of the support roller 32, or alternatively partially in both surfaces, instead of being formed in the connecting rings 41 and 42.

The aforedescribed series-connection of the channels that causes the coolant to pass in two turns around the roller periphery also affords the advantage of relatively uniform cooling of the roller mantle surface.

When, by way of comparison, we consider the series-connection of the channels configured so that cooling water from one channel is delivered to the nearest adjacent channel and from this channel to the channel which lies nearest thereto, so that the water is passed only through one turn around the cooled roller before being discharged, there will be obtained a continuous temperature gradient in the same direction around the

roller as that through which the water passes through the channels. This water will be heated successively with each passage through a channel, and consequently the first channel will conduct the coldest cooling water and the water will then become warmer with each channel it passes through.

For instance, if, for the purpose of illustration, we consider the case in which the cooling water passed to the first channel has a temperature of 0°C and the water is heated by 2°C during its passage through each channel, the water in the last of the thirty-one channels will have a temperature of 62°C, in the nearest preceding channel a temperature of 60°C, and in the penultimate channel a temperature of 58°C, and so on. On the other hand, if the cooling water is allowed to miss each alternate channel, so that it passes in two turns around the roller before being discharged, the temperature in the last channel will be 62°C, as in the previous case, whereas the temperature of the water in the immediately preceding channel, which belongs to the first turn, will be 32°C, while the temperature of the water in the channel immediately preceding this channel will be 60°C, and the temperature of the water in the channel that precedes this channel will be 30°C, and so on. This results in a significantly more uniform cooling effect around the roller periphery and will therefore greatly reduce deformation in the roller as a result of thermal stresses therein. The average temperature between two mutually adjacent channels will therewith be lower than in the first case, meaning that the total temperature gradient around the roller will decrease.

Figure 4 is a spreadsheet illustrating the channel system in the roller shown in Figures 1-3, from which

it will be seen that water does not pass through mutually adjacent channels during one and the same turn around the roller.

Figure 5 illustrates a cooling roller 32 according to Figure 1 which includes a plurality of series-connected coolant channels 50-60. In practice, there is suitably used a large number of channels, although for the sake of simplicity the illustrated embodiment includes only eleven channels. As with the earlier embodiment, the coolant channels of the Figure 5 embodiment are connected in pairs at respective ends of the support roller, so that in each case two channels on different sides of an intermediate channel are connected so that the coolant water is forced to pass through two turns around the roller periphery, between the swivel inlet 33 and the swivel outlet 40.

However, in this case, the channels are not connected with the aid of outer connecting rings, but with the aid of V-shaped bores which extend from the roller periphery, see Figures 6 and 7. Each bore thus passes one channel end and meets at its inner end a bore which passes through the channel end of a channel located on the other side of an intermediate channel. The bores are subsequently sealed with external plugs, which are ground down flush with the mantle surface of the roller. Adjacent pairs of V-shaped bores are displaced axially in relation to one another, so as to pass free from each other, wherein adjacent channels also extend to mutually different lengths towards respective end surfaces of the roller.

Another difference between the embodiment illustrated in Figure 5 and the embodiment illustrated in Figure 1 is that series-connection of the channels in the Figure

5 embodiment is such that during its passage through two turns around the roller periphery, the water will pass in one direction during one turn and in another direction during the other turn, thereby achieving a still more uniform cooling effect around the mantle surface of the roller, as will be explained in more detail herebelow.

As in the case of Figure 1, we now follow the cooling water which, similar to the case in Figure 1, is delivered to the first coolant channel 50 through the radial channel 37. The cooling water is switched to the coolant channel 51 at the left end of the channel 50 in Figure 5 via two V-shaped bores 62 and 63, and at the right end of the roller, the water is delivered from the channel 51 to the channel 52 through V-shaped bores 64 and 65, and so on. After travelling about one turn around the roller, the water returns through the channel 55 which, however, is in direct connection with the channel 56, see Figure 7, from which the water at the left end of the roller is switched to the channel 57, and so on, until after having travelled through about one turn in the other direction returns through the channel 60 which is connected with the centre channel 66 of the roller, and therewith the swivel outlet pipe 40, through the radial channel 39. Thus, during its passage between the swivel inlet 33 and the swivel outlet 40, the water will have passed twice around the roller periphery in mutually different directions.

The principle according to which the coolant channels are mutually connected will be evident from the spreadsheet in Figure 8. If it is assumed, solely by way of a theoretical example with the intention of facilitating an understanding of the description, that the cooling water in the inlet channel 37 has a tem-

perature of 0°C and that this water is heated by 5°C with each passage through a coolant channel, the temperatures given in Figure 8 will be achieved. The average temperature between each pair of adjacent channels has been indicated to the left. As will be seen from these values, a highly uniform temperature distribution is obtained around the roller periphery, which further reduces the risks of deformation to the roller as a result of thermal stresses and results in highly uniform cooling of the sheet steel shape.

Although the invention has been described in the aforegoing with reference to two preferred exemplifying embodiments thereof, it will be understood that these embodiments can be modified in several respects within the scope of the following Claims. For instance, the method of mutually connecting the coolant channels can be varied, irrespective of whether the cooling water shall pass through two turns around the roller periphery in one and the same or in different directions, wherein combinations of the described methods can be used, among other things. Furthermore, the cooling water outlet and inlet may also be located at opposite ends of the roller. The aforedescribed roller cooling principle for cooling steel plate shapes can be used in every other context in which such cooling is desired. For instance, an equivalent application is one of heating rollers, which can then be effected in a similar manner with the aid of hot water or steam. The inventive principle enables any desired number of coolant channels to be included, this number being determined by the application in question.

CLAIMS

1. A cooled support roller, particularly for use in the continuous casting of steel shapes, comprising a plurality of axially extending coolant channels (1-31; 50-60) which are distributed uniformly around the periphery of the roller (32) and connected in series between a coolant inlet (33) and a coolant outlet (40), characterized in that the channels (1-31; 50-60) are so connected in series that during its passage through said channels between the inlet (33) and the outlet (40), the coolant will pass through two turns around the periphery of the support roller (32); and in that the coolant is caused to pass through each alternate channel during the first turn around said roller periphery and through intermediate channels during the second turn around said periphery.

2. A support roller according to Claim 1, characterized in that the end of a coolant channel (1) at one end of the support roller (32) is connected to the corresponding end of the next nearest coolant channel (2) on one side; and in that the opposite end of the same coolant channel (2) is connected at the other end of the support roller to the corresponding end of the next nearest coolant channel (3) on the other side.

3. A support roller according to Claim 2, characterized in that all coolant channels, with the exception of the channels (1, 31) connected to the inlet and the outlet are connected in mutually the same manner, wherein coolant will pass two turns in mutually the same direction around the support roller periphery during its passage between the inlet (33) and the outlet (40).

4. A support roller according to Claim 2, c h a r a c t e r i z e d in that the end of the coolant channel (55) through which coolant exits after having passed through a first turn around the support roller periphery is connected to a corresponding end of the nearest coolant channel (56) which was by-passed at the opposite end of the support roller, when the coolant was delivered to the first mentioned channel (55), so that coolant will pass through a second turn around the support roller periphery in a direction opposite to the coolant direction in the first turn.

5. A support roller according to any one of Claims 1-4, c h a r a c t e r i z e d in that a coolant channel connecting ring (41, 42) is arranged in sealing abutment with both end surfaces of the support roller (32); in that each alternate coolant channel passes into the ring and is connected with one of the nearest adjacent channels in the ring by means of a connecting aperture (44) formed in said ring; and in that the boundary surface between the roller (32) and a respective ring (41, 42) is provided with curved, groove-shaped recesses (43) which connect in pairs those channels that are located on each side of each channel that extends into the ring.

6. A support roller according to Claim 5, c h a r a c t e r i z e d in that the connecting apertures formed in the ring (41, 42) have the form of apertures (44) milled from the mantle surface of the ring, these milled apertures being closed by means of a material which is ground down to the level of the mantle surface.

7. A support roller according to any one of Claims 1-4, c h a r a c t e r i z e d in that the coolant

channels at both ends of the support roller (32) are connected together in pairs by means of V-shaped bores (62-65), each of which passes from the roller mantle surface a respective coolant channel on different sides of an intermediate coolant channel; and in that adjacent pairs of V-shaped bores are displaced axially in relation to one another.

8. A support roller according to any one of Claims 1-7, characterized in that the coolant inlet and outlet (33, 40) are connected to the same end of the support roller (32).

9. A support roller according to Claim 8, characterized in that the inlet and outlet (33, 34) are connected to internal and external coaxial passages (35, 66) in the support roller (32); in that the internal passage (35) is connected with a radially extending connecting channel (37) which leads to one of the coolant channels (1; 50) and which is located at the end of the support roller remote from the inlet and the outlet; and in that the external passage (66) is connected at the inlet and outlet end of the support roller with a radially extending connecting channel (39) which leads to another of the coolant channels (31; 60).

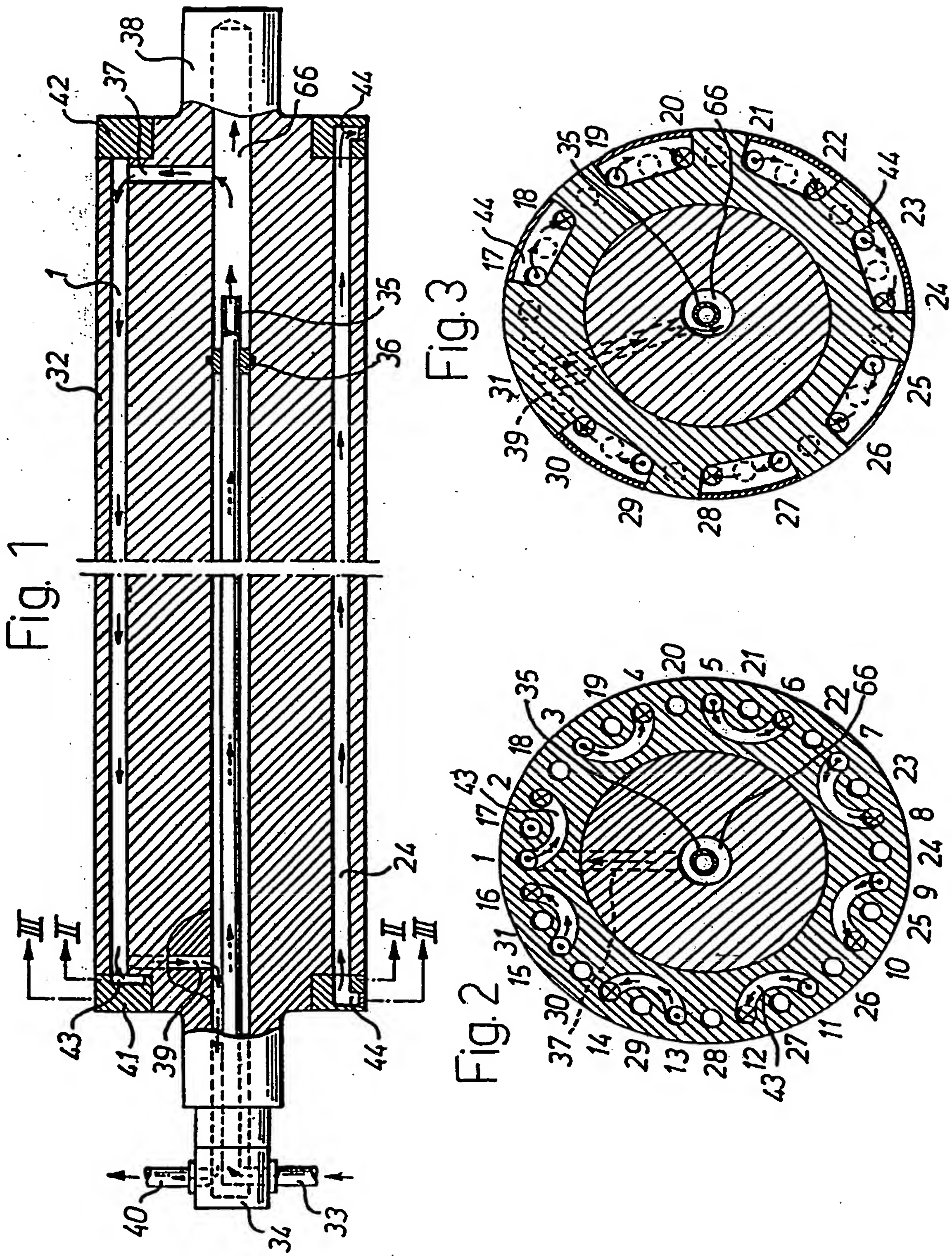
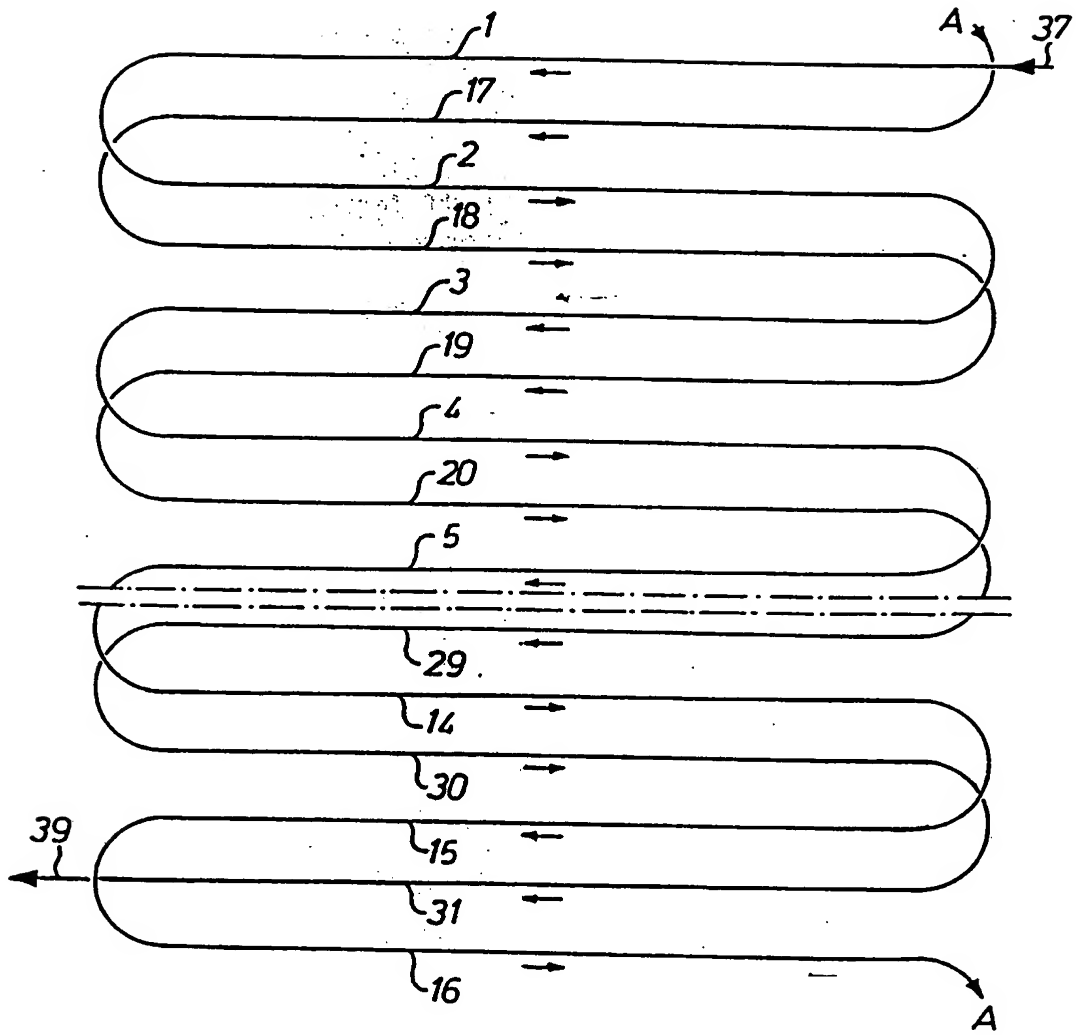


Fig. 1

Fig. 2

Fig. 3

Fig. 4



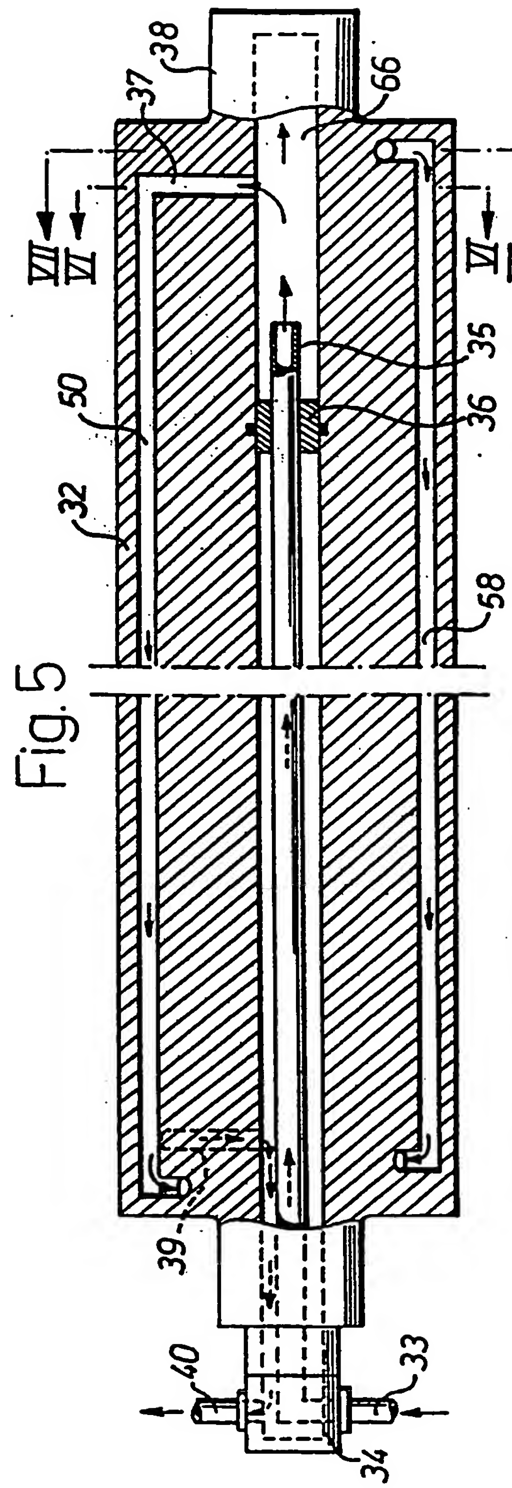


Fig. 5

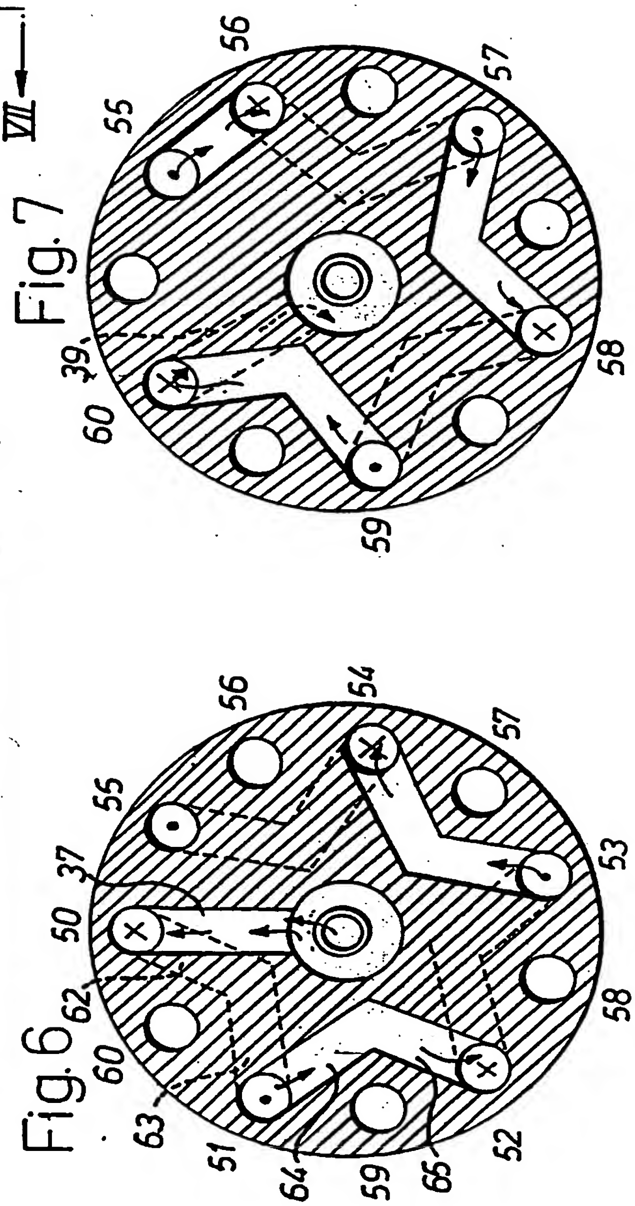
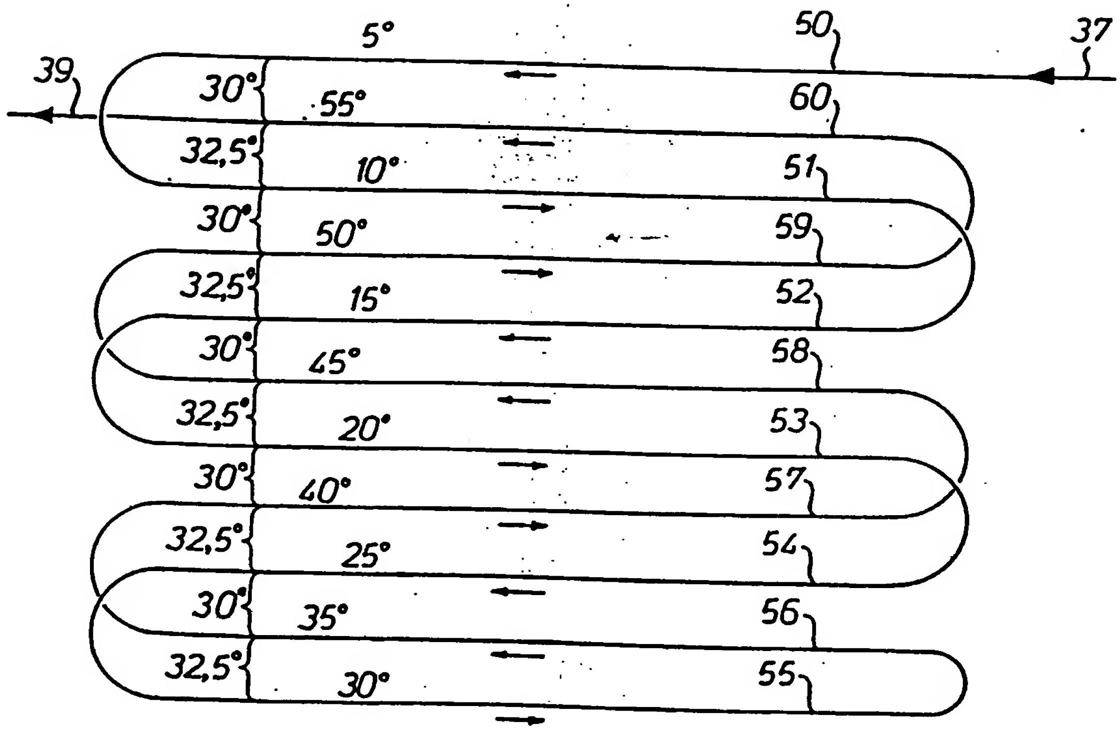


Fig. 7

Fig. 6

Fig. 8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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00250

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B22D 11/128, B21B 27/08 // F26C 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B22D, B21B, F26C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, C, 613662 (GESELLSCHAFT FÜR TEERVERWERTUNG M.B.H.), 23 May 1935 (23.05.35), page 1, line 17 - line 42, figures 1,3 --	1
A	DE, A1, 2612583 (FIVES-CAIL BABCOCK S.A.), 14 October 1976 (14.10.76), page 5, line 9 - page 6, line 23, figures 1,2 --	1
A	DE, C1, 3315376 (MANNESMANN AG), 16 August 1984 (16.08.84), figure 1, abstract -- -----	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 July 1993	08 -07- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulf Nyström Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT
Information on patent family members

28/05/93

International application No.
PCT/SE 93/00250

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE-C-	613662	23/05/35	NONE		
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			BE-A-	840080	16/07/76
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